In-Situ (Analytical) Instruments

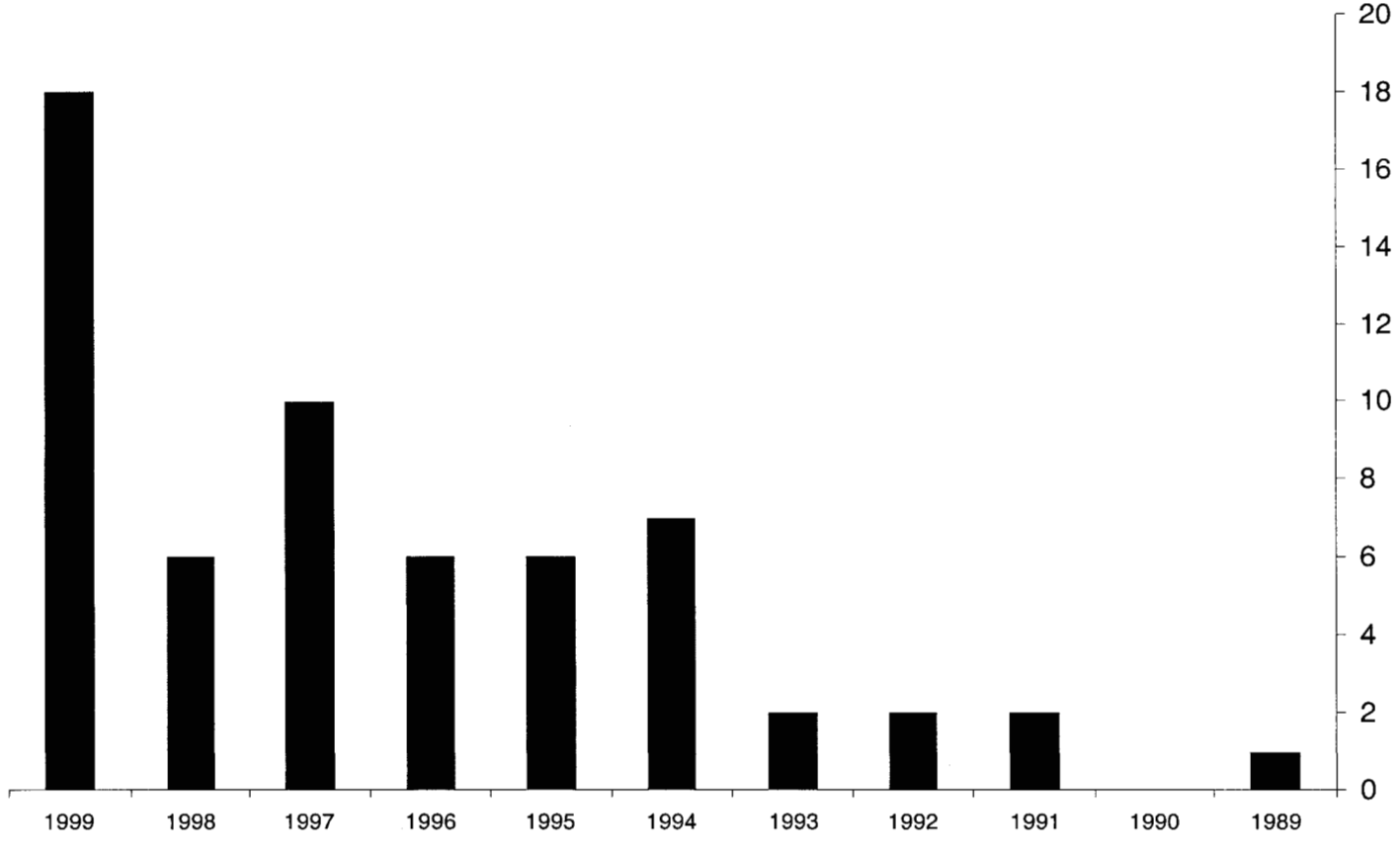
or

How did JPL get into this Biz, anyway?

- NASA missions changed from remote sensing or flyby to landers and rovers
- New Science requires sample analysis
  - Search for life-astrobiology
  - Detailed mineralogy
  - Search for materials to support human habitation-water/oxygen/ores
- New instruments with emphasis on *in-situ* analysis
  - small mass/power/footprint
  - These attributes fit commercial and NASA needs

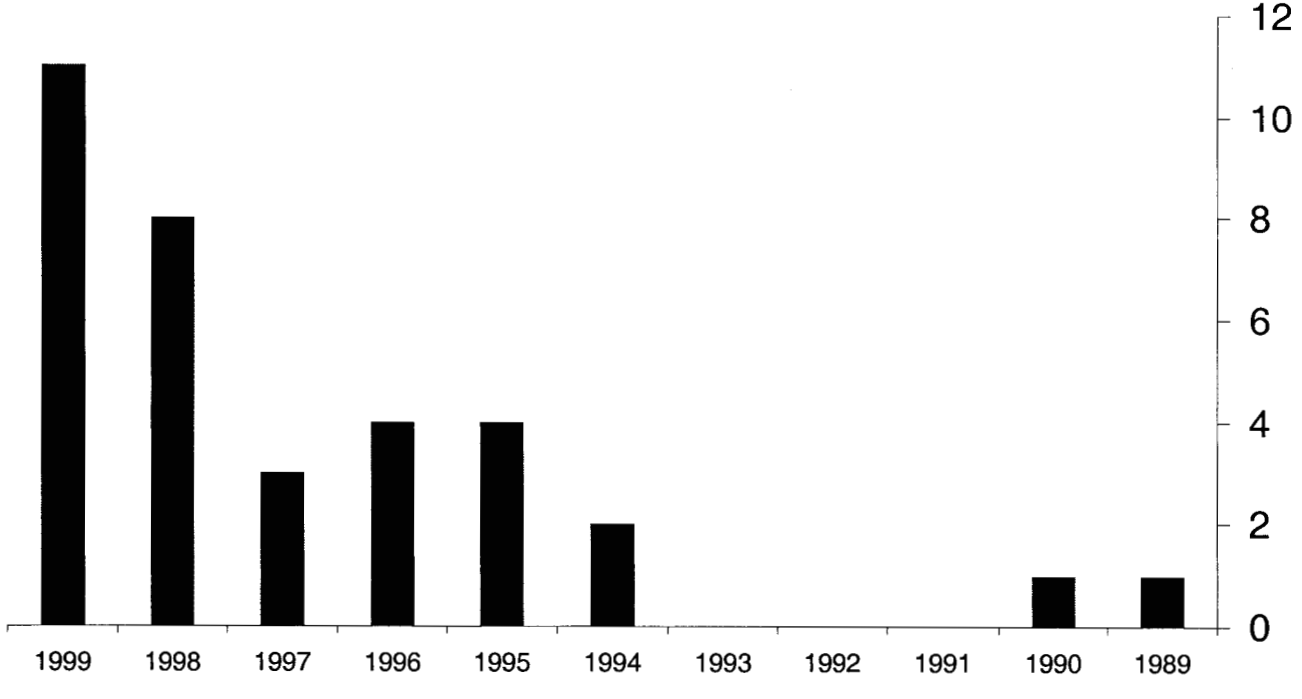
JPL Analytical Instrument History

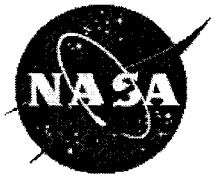
**IN-SITU ANALYTICAL INSTRUMENT New Technolgy Reports-
x-ray/gas/chemical/microscopies/mass spectrometry**



JPL Biomedical Technology History

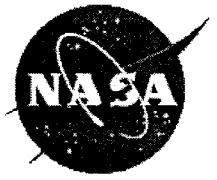
BIOMEDICAL New Technology Reports-biological/ sensor/imaging/bugs/human health





In-Situ Instruments

- New science requires "hands-on" instruments that work with samples and perform the functions of an analytical laboratory
  - Imaging-nanometer scale and up
  - Mass spectrometry
  - Gas chromatography-mass spectrometry
  - x-ray fluorescence
  - chemical composition and maps
  - elemental composition and maps
  - sensor nets for distributed instruments



Instrument Building Block Technologies

MEMS

Micro-fluidics

e-beam lithography

LIGA

integrated opto-electronics

novel materials

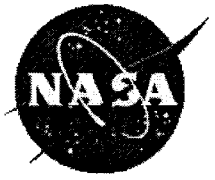
diffractive optics

Functionality I

- Optical spectroscopies
  - Imaging spectroscopy
  - Raman
  - Surface enhanced Raman
  - Tunable Diode Laser spectroscopy for gas/chemical sensors and analyzers
- Microscopies
  - Atomic Force Microscopy
  - Shear-force probe coupled with elemental Analysis-LIBS
  - Proximal atom probe-see Wilson chart
- Biodetection
  - planetary protection program-sterilization of large spacecraft
  - detection of bio-organisms on large surfaces
  - High Q cavity biosensors
  - Imaging sensors for gene/protein chips

Functionality II

- Mass Spectrometry
  - Miniature RF quadruple
  - Magnetic sector
  - rotating field
  - Ion mobility
- Sensors
  - Force NMR
  - electronic nose-chemical sensor
  - Colormetric chemical sensors-ozone, for example



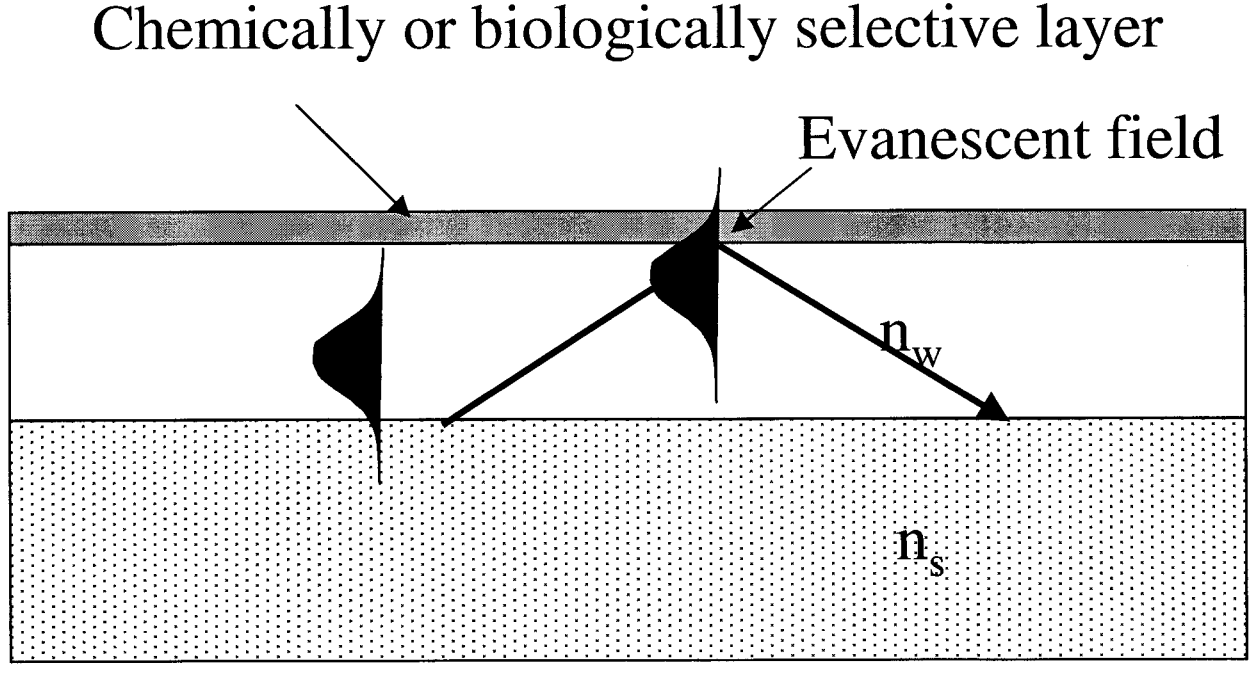
Mass Spectrometry for Disease Detection

- Volatile compounds in human breath have long been investigated for disease detection
  - lung cancer
  - organ failure
- Metabolic byproducts or *not* metabolized and should be

JPL System

- Atmospheric pressure system
- No vacuum system
- Compact
- Innovative ionizer

Evanescent wave chemical and biological sensor



JPL Technology

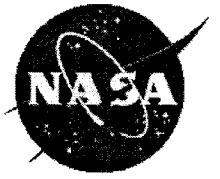
- New technique to increase sensitivity by several orders of magnitude
- Can be used with any sensor film
- May be able to make sensor arrays

Electronic Tongue

- Similar approach as E-nose
  - Array of individual ion selective sensors
  - pattern recognition algorithms that require learning-no one sensor detects only one analyte
- Aqueous environment for new applications

Analytes for which ionophores have been reported

Inorganic Cations	H^+, Li^+, Na^+, K^+, Rb^+, Cs^+, (Be^{2+}), Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mo^{4+}, Fe^{3+}, Cu^{2+}, Ag^+, Zn^{2+}, Cd^{2+}, Hg^{2+}, Tl^+, Bi^{3+}, Pb^{2+}, U^{4+}, Sm^{3+}, NH^{4+}
Inorganic Anions	CO_3^{2-}, HCO^{3-}, SCN^-, NO^{2-}, OH^-, phosphate, sulfite, SO_4^{2-}, Cl^-, SeO_3^{2-}, I^-
Organic Cations	1-phenylethylamine, 1-(1-naphthyl)-ethylamine, ephedrine, norephedrine, pseudoephedrine, amphetamine, propranolol, amino acid methyl esters, α-amino-ε-caprolactam, amino acid amides, benzyl amine, alkyl amines, dopamine, mexiletine, local anaesthetics (procaine, prilocaine, lidocaine, bupivacaine, lignocaine), diquat and paraquat (herbicides), tetramethyl- and tetraethylammonium, guanidine, metformin, phenformin, creatinine, protamine
Organic Anions	salicylate, phthalate, maleate, 2-hydroxybenzhydroxamate, nucleotides, heparin
Neutral Analytes	CO_2, O_2, NH_3



JPL Technology is *Early* Technology

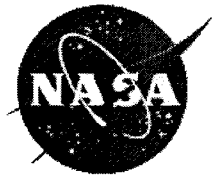
- JPL typically does not produce or patent technology at a level suitable for commercialization "as is"
- Goal is to produce instruments for science return
  - one of a kind
  - not reusable
  - science return is major driver, not cost
  - highly trained users or support staff acceptable
  - hardwired design that may be difficult to repair or manufacture in bulk

Technology Gaps

- JPL may have proof-of-concept experiment only
- The technology may need work in
  - manufacturability
  - process control
  - sensitivity
  - redesign away from instrument configuration
- These gaps need to be bridged to bring product to market-*money and time*
- Can perform the work at JPL with the inventor(s)
- Can perform the work in-house with inventor as consultant or without

How do you work with JPL/CIT?

- JPL's technology and intellectual property is mostly owned by the California Institute of Technology
  - JPL is operated by CIT for NASA and may elect to file on intellectual property under the Bayh-Dole act.
  - NASA may own some IP
- Licensing goes through the CIT office of Technology Transfer
- Licensee can work with JPL inventor to bridge the "gaps" to make a marketable device
  - JPL Technical Affiliates Program-need access to specialized equipment or expertise at JPL
  - Technical Affiliates is an existing program with a minimum of legal boilerplate that allows outside companies to fund work at JPL
  - Engage inventor as consultant



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